APPLIED MATHEMATICS
[As per Choice Based Credit System (CBCS) scheme]
I SEMESTER

Course Code	**18MAU11**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

Course Objectives:

- **Course objectives:** The main objective of the course is to enhance the knowledge of principles of numerical methods, partial differential equations, linear transformations, solution of linear algebraic equations and Eigen value problems with a greater accuracy required for the general applications of mechanical engineering sciences.

Module-1

Approximations and round off errors: Significant figures, accuracy and precision, error definitions, round off errors and truncation errors. Mathematical modeling and engineering problem solving: Simple mathematical model, Conservation laws of engineering. Roots of polynomial-polynomials in engineering and science, Muller's method, Bairstow's Method Graeffe's root squaring method. L1, L3

Module-2

Roots of Equations: False position method, Newton- Raphson method. Multiple roots by Newton-Raphson method. Simple fixed point iteration method- Acceleration of convergence- $\Delta 2$ - Aitken's method. Numerical Differentiation and Numerical Integration: Newton –Cotes and Guassian Quadrature Integration formulae, Integration of Equations, Romberg integration, Numerical Differentiation Applied to Engineering problems, High Accuracy differentiation formulae. L1, L3

Module-3

Numerical Solution for Partial Differential Equations: Classification of second order partial differential equations. Solution of one dimensional heat equation by explicit method and Crank-Nicolson method. Solution one dimensional wave equation and two-dimensional Laplace equation by explicit method. L1, L3

Module-4

System of linear algebraic equations and eigen value problems: Introduction, Direct methods, Gauss elimination method, triangularization method, Cholesky method, Partition method, Error analysis for direct methods. Eigen values and eigen vectors: bounds on eigen values, Jacobi method for symmetric matrices, Givens and Householder's method for symmetric matrices. Power method and Inverse power method. L1, L3

Module-5
Linear Transformation: Introduction to linear transformation. The matrix of linear transformation, linear models in science and engineering. Orthogonality and least squares: inner product, length and orthogonality, orthogonal sets, orthogonal projections. Gram-Schmidt process, least-square problems, inner product spaces. L1, L3
Course outcomes: 1. Employ numerical techniques in order to achieve more accurate values in the computation of roots of polynomials and non-linear equations. 2. Understand vector spaces, basis, linear transformations and the process of obtaining matrix of linear transformations arising in magnification and rotation of images. 3. Utilize standard numerical schemes to solve partial differential equations applicable to mechanical engineering problems. 4. Apply the numerical linear algebra techniques to solve algebraic, transcendental and matrix eigen value problems. 5. Employ the idea linear transformations, inner product spaces and orthogonality to design linear models occurring in science and engineering.
Text Books: 1. S. S. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall of India, 4th Edition, 2006. 2. Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, Tata Mcgraw Hill, 3rd Ed, 2011. 3. David C. Lay, Steven R. Lay and J.J. McDonald, Linear Algebra and its Applications, 5th Edition, Pearson Education Ltd., 2015.
Reference Books: 1. B. S. Grewal, Numerical methods in Engineering and Science (with C, C++,&MATLAB), Khanna Publishers, 2014. 2. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International Publishers, 9th Edition, 2014. 3. PervizMoin, Fundamentals of Engineering Numerical Analysis, Cambridge University Press, 2010.

AUTOMOIVE ENGINE AND SYSTEMS
[As per Choice Based Credit System (CBCS) scheme]
I SEMESTER

Course Code	**18MAU12**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

Course Objectives: This course will enable students to

- Understand basics of internal combustion engine
- Design of Combustion chamber for SI and CI engines.
- Select the cooling and lubrication systems for given engine, suitable engine management system, also calculate heat lost in lubrication and cooling system
- Calculate engine performance characteristics.

Module-1

Introduction:
Definition of a Heat engine; external and internal combustion engine; basic engine components and nomenclature; the working principles of engines; classification of IC engines; applications of IC engines, components of I. C. engine, types, their functions and materials.

Fuel Supply Systems:
SI Engine: Principle of elementary carburetor, Mixture requirements for steady state and transient operation, Gasoline Fuel Injection.
C.I. Engines: Fuel injection pump systems- Types, constructional features and operation, Factors influencing fuel spray atomization, penetration and dispersion of diesel, Fuel Injection Pumps (inline, rotary), Filters, Governors – Types of Governors - fuel feed pumps and Types, injectors and nozzles – types, functions and necessities, injection lag, pressure waves in fuel lines. L1, L2

Module-2

Combustion in S. I. engines: Essential features of ignition timing and ignition voltage, MBT timing, knock detection and control strategies, thermodynamic analysis of SI engine combustion, analysis of cylinder pressure data, requirements of combustion chambers, and types of combustion chambers.
Combustion in C. I. engines: Essential features of injection timing and delay period, correlations for ignition delay in engines, effect of fuel properties, types of combustion chambers and merits of the different types, analysis of cylinder pressure data, fuel spray behavior. L1, L2, L3

Module-3

Cooling and Lubrication System:
Cooling System: Necessity, variation of gas temperature, Areas oh heat flow, heat transfer, piston and cylinder temperature, Heat rejected to coolant, quantity of water required, cooling system, air cooling, water cooling,

thermodynamics of forced circulation, thermostats, pressurized water cooling, regenerative cooling, comparison of air and water cooling, radiators types, cooling fan – power requirement, antifreeze solution.

Lubrication System: Lubricants, lubricating systems, Lubrication of piston rings, bearings, oil consumption, Oil cooling. Heat transfer coefficients, liquid and air cooled engines, coolants, additives and lubricity improvers, oil filters, pumps, and crankcase ventilation – types. L1, L2, L3

Module-4

Engine Management System: Combined ignition and fuel management systems, Digital control techniques. Complete vehicle control systems, Artificial intelligence and engine management, Exhaust emission control in SI and CI engines Techniques.

Recent Developments in Automotive Engines : Supercharger, Working Principle, Effect of Super charging, Types and Methods of Super charging, Turbo Charger, Working Principle , Turbo-lag, VVT, V-TEC i-VTEC and IDTEC. ATFT, CRDI system- working Principle, Advantages and Effect of CRDI on emission reductions, Hybrid vehicles and fuel cells. L1, L2, L3

Module-5

Engine Performance Testing: Engine performance parameters; Methods of determination of BP, IP, FP, volumetric, thermal, mechanical, scavenging efficiencies, etc., types of dynamometers, Morse Test, Numerical Problems in Engine Testing, Engine Performance and heat balance sheet. L1, L2, L4

Course outcomes: Course: After completion of above course, student will be able to:

- Explain air fuel requirement for various operating conditions of engine, various layouts and working of various injection systems, engine cooling system, lubrication system, engine management systems, exhaust emission control techniques, recent development ins engines, etc.
- Analyze the combustion normal and abnormal combustion process, basic principles for selection of combustion chambers.
- To calculate heat lost to the coolant, engine performance in terms of various performance parameters by conducting test on single cylinder and mylti cylinder engine.

Text Books:

1. John B.Heywood, Internal Combustion Engine Fundamentals, McGraw-Hill Book Company(1988)
2. Dr. K. K. Ramalingam, Introduction to Internal Combustion Engines, Scitech Publication, 2004
3. V. Ganesan, Internal Combustion Engines, Tata McGraw Hill Publications.

Reference Books:

1. Tom Denton, Automotive Electrical and Electronics, SAE, 2000
2. Heinz Heisler, Advanced Engine Technology, SAE Publications, 1995.
3. Richard Van Basshuysen, Internal Combustion Engine Hand Book, Fred Schaefer, SAE(2004).

NOISE, VIBRATION AND HARSHNESS
[As per Choice Based Credit System (CBCS) scheme]
I SEMESTER

Course Code	**18MAU13**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

Course Objectives: This course will enable students to

- Understand basics of noise, vibration and harshness, various noise measuring instruments.
- Identify the sources of noise in engine, power train and vehicle body.
- Analyze NVH and take necessary steps to reduce it.

Module-1

Fundamentals of sound:

Definition of NVH, Vehicle noise - Direct sound generation mechanism: airborne sound; Indirect sound generation mechanism: structure borne sound; Subjective response sound, Acoustic variables, basic attributes of sound such as wavelength, period, frequency; speed of sound, Decibel scale, Wave equation, types of sound fields, Measures of sound: Sound pressure, sound intensity and sound power, Combining sources: dB arithmetic, Standing wave, Beating, Impedance, Human hearing: frequency Versus sound pressure level, Loudness: phons and sones as noise descriptors; Weighting networks, Leqand various noise metrics for road noises. L1,L2

Module-2

Noise measurements and Instrumentation:

Measuring microphones, Sound level meter, time and frequency weighting, Sound spectra – Octave band analysis, Order analysis and waterfall plot, Various types of acoustic testing chambers, Sound power measurement from Sound pressure: Two- microphone probe for measuring; Sound power measurement from Sound Intensity L1, L2, L3

Module-3

Sound fields and Room Acoustics:

Characterizing sound sources; Directivity; Sound Fields; Various approaches to modeling sound sources; Transmission loss (TL) and Insertion loss (IL); Reverberation time and Acoustic Absorption Coefficient; Effects of leaks on barrier and TL of composite barriers; measurement Absorption Coefficient and Transmission loss (TL).

Vehicle Interior and Exterior noise:

Internal noise sources in vehicles such as engine noise; road noise; aerodynamic (wind) noise; brake noise; squeak, rattle and tizz noises; sound package solution to reduce the interior noise: acoustic isolation, acoustic absorption and damping material solutions; Exterior noise sources in vehicles

such as air intake systems and exhaust systems; Tyre noise. L1, L2, L3

Module-4

Sources of Vehicle Vibration:

Power train and Engine vibrations; driveline vibrations; chassis and suspension vibrations; Control strategies; Human response to vehicle vibrations, concept of harshness; subjective and objective evaluation of vehicle harshness.

Vibration Isolation and Control:

Introduction; damping of vibrations; vibration isolation and absorption; design of a Vibration Absorbers, unconstrained and constrained layer damping treatment, add on dampers and stiffeners, Introduction to Active Vibration Control. L1, L2, L3,

Module-5

Vibration Measurement and Instrumentation:

Definition of Modal Properties, Modal analysis theory, FE & Experimental modal analysis, Transducers and accelerometers Excitation sources Impact Excitation, Shaker excitation, Excitation signals, applications of Modal Analysis, laser based vibration measurements; analysis and presentation of vibration data. L1,L2,L3, L4

Course outcomes:: After completion of above course, student will be able to:

- Explain basics of NVH.
- Use different instruments and analyse the data for identification of sources of noise and vibrations.
- Conduct testing of vehicle components for vibrations.
- Take necessary steps to reduce the levels of vibrations and noise in automobiles.

Text Books:

1. Bies D. A. and Hansen C. H., Engineering Noise Control: Theory and Practice-, Spon Press, Taylor &Francis, NYUSA, 2003.
2. Xu. Wang, Vehicle Noise & Vibration Refinement, Elsevier Publishing Limited, 2010.
3. Mathew Harrison, Vehicle Refinement- Controlling Noise & Vibration in Road Vehicles, Elsevier Publication(2004).

Reference Books:

1. William W. Seto, Theory and Problems of Mechanical Vibrations, McGraw Hill International BookCo., Singapore (Schaum's outline series)
2. S. S. Rao, Mechanical Vibrations, Pearson Education Inc.,
3. S. Graham Kelly,MechanicalVibrations,Schaum's Outline Series, Tata McGraw Hill Publishing Co.Ltd., New Delhi.

AUTOMOTIVE CHASSIS
[As per Choice Based Credit System (CBCS) scheme]
I SEMESTER

Course Code	**18MAU14**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

Course Objectives: This course will enable students to

1. Understand basics layout and components of automotive chassis.
2. Select and Design frames automobiles.
3. Explain construction, working and design of various chassis components.
4. Identify chassis components trouble and remedies.

Module-1

Overview of Vehicle Chassis System:
General construction of chassis, Types of chassis layouts with respect to location of Power plant and drive arrangements and their comparison. Stability of vehicle on slope, weight distribution, numerical on abovetopics.

Frames:
Types of frames, loads acting of frame, cross sections and materials for frames, loading points, sub frames, calculation of cross section of frame members, Testing of frames numerical on above topics. L1, L2, L4

Module-2

Front axle and Steering Systems:
Front axle: Types of front axles and stub axles, Axle parts and materials, loads and stresses, center sections, section near steering head, spring pads, Front wheel geometry- Camber, Castor, toe –in, toe out, King Pin Inclination, under steer and over steer conditions, etc., calculation of cross sections of front axles.

Steering Systems: Condition for correct steering, types of steering gears, power steering, Types of linkages, Ackermann and Davis steering mechanisms, Reversible and Irreversible steering. L1, L2, L3

Module-3

Suspension System:
Need, functions and requirements of suspension system, types of suspension system, Constructional details of leaf spring, helper springs, coil springs, torsion bar, rubber springs, plastic springs, air bellows or pneumatic suspension, hydraulic suspension, constructional details of telescopic shock absorbers, independent suspension, front wheel independent suspension, rear wheel independent suspension, types, stabilizer, trouble shooting. L1, L2, L3

Module-4

Brakes:

Necessity and requirements of brakes, stopping distance and time, brake efficiency, weight transfer, brake shoe theory, determination of braking torque, Classification of brakes, constructional details- Drum brakes, Disc brakes Hydraulic brake system, Pneumatic brakes, Power assisted Braking system, Servo Brakes, Anti-lock Braking system, Retarders, Hill Holders, requirements of brake fluids, requirements and construction of brake shoes, trouble shooting. L1, L2, L3,L4

Module-5

Rear Axles:
Construction of rear axles, Types of loads acting on rear axle, Full floating, Three Quarter Floating and Semi – floating axles, Hotchkiss and torque tube drive.

Wheels and Tyres: Types of wheels, construction, structure and function, wheel dimensions, structure and function of tyres, static and dynamic properties of pneumatic tyres, types of tyres, materials, tyre section & designation, factors affecting tyre life, special wheels, trouble shooting. L1,L2,L3

Course outcomes: After completion of above course, student will be able to:

- Differentiate various types of chassis layouts frames, front axles, springs, rear axles arrangements and other chassis components with their advantages and disadvantages.
- Explain construction and working of various chassis components with materials.
- Design various chassis components.
- Identify various faults in chassis components and methods of rectification.

Text Books:

1. P.M. Heldt, Automotive Chassis, Chilton & Co.
2. N.K. Giri, Khanna Publications, Automotive Mechanics–New Delhi,2004

Reference Books:

1. Joseph I Heintner, Automotive mechanics, Affiliate d East West Press, New Delhi/Madras,1967
2. Kirpal Singh, Automobile Engineering Vol. I, Standard publications, New Delhi.

ALTERNATIVE FUELS AND POLLUTION CONTROL
[As per Choice Based Credit System (CBCS) scheme]
I SEMESTER

Course Code	**18MAU15**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**04 (50 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

Course Objectives: This course will enable students to

- Understand need for alternative fuels for automobiles, alternatives available, their advantages and disadvantages.
- Select suitable alternative fuel for given internal combustion engine depending on properties, storage, emissions etc.
- Design internal combustion engine for lower emissions.
- Select suitable post combustion treatment method for reduction of emission of pollutants to environment.
- Select suitable instrument for measurement of emissions.

Module-1

Introduction:

Types of energy sources, their availability, need of alternative energy sources, Non-conventional energy sources, Classification of alternative fuels, Scenario of conventional auto fuels, fuel quality aspects related to emissions. Technological up gradation required, business driving factors for alternative fuels. Implementation barriers for alternative fuels.

Gaseous Alternative Fuels:

Hydrogen:

Introduction, properties and production of hydrogen. Storage, Advantages and disadvantages of hydrogen as fuel for S. I. and C. I. engines. Hazards and safety systems for hydrogen, hydrogen combustion. Performance and emission of from hydrogen.

Other Gaseous Fuels:

Properties, production, advantages and disadvantages of LPG, CNG, Methanol and Ethanol and their blends as Fuel for SI and CI engine. L1,L2,L3

Module-2

Bio-Diesel:

Straight vegetable oil, Biodiesel-Production of Bio-Diesel, Bio-Diesel as Fuel for CI engine, Performance and emission of bio diesel.

Biogas or Biomethane:

History, properties and production of Biogas, classification of biogas plants, biogas storage and dispensing system. Advantages of biogas, hazards and emissions of biogas.

Reformulated conventional fuels

Introduction. Production of coal water slurry. Properties, as an engine fuel,

emissions of CWS. RFG, Emulsified fuels. Hydrogen-enriched gasoline. Future Alternative Fuels, PMF, Ammonia, Liquid-Nitrogen. L1,L2,L3

Module-3

Source of Emission from Automobiles:

Sources of Air Pollution. Various emissions from Automobiles- Formation- Effects of pollutants on environment and human beings.

S. I. Engine Emissions and its Control:

Emission formation in SI Engines- Carbon monoxide & Carbon dioxide - Unburned hydrocarbon, NOx, Smoke-Effects of design and operating variables on emission formation- controlling of pollutants - Catalytic converters, Charcoal Canister, CCS, Positive Crank case ventilation system, Secondary air injection, thermal reactor, Laser Assisted Combustion, etc. L1, L2, L3

Module-4

C. I. Engine Emission and its Control:

Formation of White, Blue, and Black Smoke, NOx, soot, sulphur particulate and Intermediate Compounds - Physical and Chemical delay- Significance Effect of operating variables on Emission formation- Fumigation, Split injection, Add Blue, Catalytic Coating, EGR, HCCI, Particulate Traps, SCR.

Influence of Fuel Properties on Emission and Effect of Air Pollution:

Effect of petrol, Diesel Fuel, Alternative Fuels and lubricants on emissions, Effect of air pollution on Human Health, Effect of air pollution on animals, Effect of air pollution on plants L1, L2, L3

Module 5

Test Procedures and Emission Measurements:

Constant Volume Sampling I and 3 (CVS-1&CVS-3) Systems, Sampling Procedures- Chassis dyno- Seven mode and thirteen mode cycles for Emission Sampling-Sampling problems - Emission analyzers - NDIR, FID, Chemiluminesecent, Smoke meters. L1, L2, L3, L4

Course outcomes: After completion of above course, student will be able to:

1. Explain need for alternative fuels, various alternative fuels available and their suitability for automotive application.
2. Explain sources of pollution from automobiles and effects of pollutants on living beings.
3. Select suitable means for controlling pollution from automobiles.
4. Select suitable method of sampling of pollutants and techniques for reduction of Pollution from Automobile.

Text Books:

1. G. P. Springer ad D. J. Patterson, Engine Emissions, Pollutant formation-, Plenum Press, New York, 1986.
2. S .S. Thipse., Alternative Fuels- JAICO Publishing House New Delhi.
3. G. D. Rai , Non-Conventional Energy Sources, Khanna Publishing New Delhi

Reference Books:

1. V. Ganesan, Internal combustion Engines, Tata McGraw Hill Book Co, Eighth Reprint, 2005.

2. Crouse and Anglin, Automotive Emission Control, McGraw Hill Company., New York 1993.
3. D. J. Patterson and N. A. Henin, Emission from Combustion Engine and their control', Anna Arbor Science Publication, 1985.

AUTOMOTIVE ENGINEERING LAB –I [As per Choice Based Credit System (CBCS) scheme] I SEMESTER			
Subject Code	**18MAUL16**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lab Hours	**50**	**Exam Hours**	**03**
Credits 02			

List of Experiments	
1	Linear Static (Stress) Analysis of Automotive Engine Components such as Connecting Rod, Piston, Cylinder wall, Crank Shaft using FEA software Such as ANSYS/MSC Patran / MSC Nastran and etc.
2	Modal Analysis of Automotive Engine Components using FEA software.
3	Dynamics Analysis of Automotive Engine Components using FEA Software.
4	Heat Transfer Analysis of Automotive Engine Components using FEA Software
5	Study of Random Vibration analysis.
6	Testing of Single Cylinder, Twin Cylinder and multi cylinder SI / CI engines for calculating engine performance in terms of BP, Thermal, volumetric efficiencies, with emission testing using conventional and unconventional fuels
7	Morse test for finding FP, IP, Indicated thermal efficiency and Mechanical efficiency
8	Study and tuning of CRDI engine.
9	Performance test on Variable Compression Ratio Engine to study effect of variation in compression ratio on engine performance.

RESEARCH METHODOLOGY AND IPR
[As per Choice Based Credit System (CBCS) scheme]
I SEMESTER

Course Code	**18RMI17**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**02**	**SEE Marks**	**60**
Total Number of Lecture Hours	**25 (05 Hours per Module)**	**Exam Hours**	**03**

Credits – 02

Course Objectives: At the end of this course, students will be able to

- give an overview of the research methodology and explain the technique of defining a research problem
- To explain the functions of the literature review in research.
- To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
- To explain various research designs and their characteristics.
- To explain the details of sampling designs, measurement and scaling techniques and also different methods of data collections.
- To explain several parametric tests of hypotheses and Chi-square test.
- To explain the art of interpretation and the art of writing research reports.
- To explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.
- To discuss leading International Instruments concerning Intellectual Property Rights.

Module-1

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India.

Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. L1, L2

Module-2

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed. L1, L2

Module-3

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.

Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale.

Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. L1, L2

Module-4

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis.

Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests L1, L2, L3, L4

Module-5

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection,

Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property

L1, L2, L3, L4

Course outcomes:

At the end of the course the student will be able to:

- Discuss research methodology and the technique of defining a research problem
- Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
- Explain various research designs and their characteristics.
- Explain the details of sampling designs, measurement and scaling techniques and also different methods of data collections
- Explain several parametric tests of hypotheses and Chi-square test.
- Explain the art of interpretation and the art of writing research reports Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR

Textbooks

1. C.R. Kothari, Gaurav Garg , Research Methodology: Methods and Techniques, New Age International 4th Edition, 2018
2. Ranjit Kumar, Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2)SAGE Publications Ltd 3rd Edition, 2011
3. Study Material
4. (For the topic Intellectual Property under module 5) Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013

1. Garg B.L et al, An introduction to Research Methodology, RBSA Publishers 2002
2. Anderson T.W, An Introduction to Multivariate Statistical AnalysisWiley 3rd Edition, 2003
3. Sinha, S.C, Dhiman, Research Methodology, Ess Publications 2002
4. Research Methods: the concise knowledge base Trochim Atomic Dog Publishing 2005
5. Day R.A., How to Write and Publish a Scientific Paper,Cambridge University Press 1992
6. Fink A., Conducting Research Literature Reviews: From the Internet to Paper Sage Publications 2009
7. Coley S.M. Scheinberg, Proposal Writing C.A Sage Publications 1990
8. Keith Eugene, Maskus Intellectual Property Rights in the Global Economy Institute for International Economics 2000

AUTOMOTIVE POWERTRAINS
[As per Choice Based Credit System (CBCS) scheme]
II SEMESTER

Course Code	**18MAU21**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

Course Objectives: This course will enable students to

- Understand basics of power train systems.
- Analyze the matching of engine with transmission system
- Select suitable transmission system among various alternatives like manual transmission, automatic transmission systems, etc.
- To make decision regarding selection of gear shifting mechanism and various elements of transmission system.

Module-1

Overview of Vehicle Power Trains System:

Outlines of Power Trains, Power train functions, Power train layout and components, Main and Auxiliary functions, Requirements profile, Interrelations: Direction of rotation, Transmission Ratio and Torque, Road Profiles, Load Profiles, Typical Vehicle uses and Driver types, Performance features of Vehicle Transmissions. Design trends in Transmission, Kinematical relations of power trains, Numerical problems.

Matching Engine and Transmission:

Road loads and axle loads, Deriving condition diagram, Ideal transmission and engine-transmissions matching, Total ratio and overall gear ratio- Selecting the largest power- train ratio, Selecting the smallest power- train ratio, Selecting the intermediate gears- saw tooth profile, Geometrical gear steps, Progressive gear steps, Numerical problems. L1,L2,L3,L4

Module-2

Start-up Devices:

One -way clutch, Band clutch, Multi-disk clutch, Clutch Design and Analysis, Hydrodynamic Clutches and Torque Converters: Principles, Characteristic curves of Hydrodynamic Clutches, Construction and operation of Torque Converter, Input/output characteristics, Design Considerations, Trilok Converter, Torque Converter test diagram, Interaction of engine and Trilok Converter, Numerical problems. L1, L2, L3

Module-3

Manual Transmissions:

Manual Transmission Layouts and Components, Basic gear box construction, gear-sets with fixed axles, countershaft transmission and epicyclic gears, schemes for reverse gear. Transmission Power Flows, Numerical problems.

Gear shifting mechanisms, Layout and design of Synchronizers:

Internal shifting mechanisms and External shifting mechanisms, Classification of shifting elements, synchronizer functional requirements, synchronizing process, design of synchronizers, alternative transmission synchronizers L1, L2, L3, L4

Module-4

Automatic Transmissions:

Level of automation, Gear shift mode, stepped and Continuously Variable Transmissions, synchronizer gear boxes, epicycloidal gear boxes, Car CVT'S: Van Doorne Continuously Variable Transmission (CVT) and Torotrak Continuously Variable Transmission (CVT). Design and analysis of planetary gear trains, Gear ratios and clutch engagement schedule, Clutch torques in steady state condition, Torque analysis in shifting process, Numerical problems. L1, L2, L3, L4

Module-5

Differential and Final drives:

Outline of differential theory-friction free differential, Differential with internal friction, Self locking differential, final drives: formats, performance limits, transmission ratios. Differential gears, differential locks and locking differentials, types of self locking differential, Numerical problems.

Design of other Transmission elements:

Design of slip joint, universal joint, dead & live axle, constant velocity joints, Bearing Design, Selection of ball and roller bearing, Gear box housing design. L1, L2, L3

Course outcomes:: After completion of above course, student will be able to:

1. Explain layout and components of automotive transmission.
    1. Explain detailed concept, construction and principle of operation of various types of mechanical transmission components, hydrodynamic devices, and hydrostatic devices.
    2. Select of automatic transmission system.
    3. Select differential gear ratio, final drives and the design of other transmission elements, gear shifting mechanism and synchronisers.
    4. Design bearings for transmission system and gear box.

Text Books:

1. Gisbert Lechner, Harald Naunheimer, Automotive Transmissions: Fundamentals, Selection, Design and Application, Springer-Verlag Berlin Heidelberg, New York, ISBN 3-540-65903.
2. Design Practices: Passenger Car Automatic Transmissions, Many authors, Third Edition, AE-18, SAE, Warrendale, 1994.

Reference Books:

1. J. Fenton, Handbook of Automotive Powertrain and Chassis Design, Professional Engineering Publishing, London 1998.
2. J. G. Giles, Gears and Transmissions, Vol. 4, Automotive Technology series, Butterworth, London 1969.

AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS
[As per Choice Based Credit System (CBCS) scheme]
II SEMESTER

Course Code	**18MAU22**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**04 (50 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

Course Objectives: This course will enable students to

- Understand construction and working of different batteries, charging and starting system components.
- Explain various factors effecting MBT and selection of ignition system.
- Select various chassis electrical and accessories.

Module-1

Storage Battery:

Principle of lead acid cells, plates and their characteristics containers and separators, electrolyte and their preparation, effect of temperature on electrolyte, its specific gravity, capacity and efficiency, methods of charging from D.C. mains, defects and remedies of batteries, care of idle and new batteries. Recycling Process - Recent development in batteries.

Charging :

D.C. Generators and Alternators their Characteristics. Control cutout, Electrical, Electro-mechanical and electronic regulators. Regulations for charging L1, L2, L3

Module-2

Lighting System

Wiring Requirements, Insulated and earth return system, details of head light and side light, LED lighting system, wiring colour code, Sealed beam head lamp construction, head light dazzling and preventive methods. Static and Dynamic Beaming of lights.

Starter Motor & Drives:

Battery motor starting system, condition at starting, behavior of starter during starting, series motor and its characteristics, consideration affecting size of motor, types of drives, starting circuit. L1, L2, L3

Module-3

Ignition systems and Engine Management Systems:

Ignition fundamentals, Types of solid state ignition systems, components, construction and operating parameters, high energy ignition distributors, Electronic spark timing, Ignition Advance, Types DIS, MBT and control.

Combined ignition and fuel management systems. Exhaust emission control, Digital control techniques – Dwell angle calculation, Ignition timing calculation

and Injection duration calculation. Complete vehicle control systems, Artificial intelligence and engine management L1, L2, L3

Module-4

Chassis systems:

Antilock brakes (ABS), Types, Active suspension, Traction control, Electronic control of automatic transmission, other chassis electrical systems, Central locking, Air bags and seat belt tensioners. Microprocessor and Microcomputer controlled devices in automobiles such as instrument cluster, Voice warning system, Travel information system, GPS, AUTOCOP, Keyless entry system. L1, L2

Module 5

Accessories:

Warning and alarm instruments: Brake actuation warning system, traficators, flash system, oil pressure warning system, engine over heat warning system, air pressure warning system, speed warning system, door lock indicators, neutral gear indicator, horn design, permanent magnet horn, air & music horns. Wind shield wiper. Window washer, instrument wiring system and electromagnetic interference suppression, wiring circuits for instruments, electronic instruments, dash board illumination and MIL. L1, L2

Course outcomes:: After completion of above course, student will be able to:

- Select suitable storage batteries used in Automobiles.
- Select suitable charging, starting and lighting systems.
- Explain various chassis electrical systems.
- Select different Ignition systems and Engine Management Systems.
- Select suitable accessory for vehicle.

Text Books:

1. Modern Electrical Equipment of Automobiles - Judge A.W., Chapman and Hall, London, 1992.
2. Understanding Automotive Electronics - William B. Ribbens, 5th edition-Butter worth Heinemann, 1998
1. Automobile Electrical Equipment - Young. A. P.,& Griffiths. L., English Language Book Society & New Press, 1990.

Reference Books:

1. Automotive Hand Book -Bosch, SAE, 8th Edn.
2. Storage Batteries - Vinal. G.W., John Wiley & Sons inc., New York, 1985.
3. Automobile Electrical Equipment – Crouse W. H., McGraw Hill Book Co Inc., New York, 1980.
4. Electrical Ignition Equipment – Spread bury F. G., Constable & Co Ltd., London, 1962.
1. Automotive Computers and Digital Instrumentation - Robert N Brady, Prentice Hall, Eagle Wood Cliffs, New Jersey, 1988.

AUTOMOTIVE BODY ENGINEERING AND SAFETY
[As per Choice Based Credit System (CBCS) scheme]
II SEMESTER

Course Code	**18MAU23**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

Course Objectives: This course will enable students to

- Understand basic classification of vehicle bodies, ergonomic requirement for driver and passengers.
- To calculate the aerodynamic forces and moments and to use farious method for reduction of aerodynamic factors.
- Gain sufficient knowledge for calculation of various forces acting on vehicle body and designing of body structure.
- To make decision regarding application of safety systems in automobiles.

Module-1

Introduction:
Types of car bodies, bus bodies and commercial vehicle bodies.

Interior Ergonomics:
Introduction, Seating dimensions, Interior ergonomics, ergonomics system design, seat comfort, requirements of drivers and passenger seats, suspension seats, split frame seating, back passion reducers, dash board instruments, electronic displays, commercial vehicle cabin ergonomics, mechanical package layout, goods vehicle layout. Visibility, regulations, drivers visibility, methods of improving visibility, Window winding and seat adjustment mechanisms. L1,L2,L3

Module-2

Aerodynamics:
Basics, Vehicle drag and types, Various types of forces and moments, effects of forces and moments, various body optimization techniques for minimum drag, Principle of wind tunnel technology, flow visualization techniques, tests with scale models, aerodynamic study for heavy vehicles.

Body Materials, Trim and Body Mechanisms:
Steel sheet, timber, plastic, glass, GRP, properties of materials - Corrosion - Anticorrosion methods – Selection of paint and painting process - Body trim items - Body mechanisms. L1,L2,L3

Module-3

Noise and Vibration:
Noise characteristics, Sources of noise, sound measurement techniques: Sound level meter, time and frequency weighting, Sound spectra – Octave band analysis, Various types of acoustic testing chambers, Sound power measurement from Sound pressure: Free field method, Reverberant field method, Semi- Reverberant field method and Comparison method (using

calibrated Sources) Two- microphone probe for measuring; Sound power measurement from Sound Intensity, Body structural vibrations, chassis bearing vibration, designing against fatigue, methods of noise suppression. L1,L2

Module-4

Body Loads and Design of Vehicle Bodies:

Idealized structure-structural surface, shear panel method, symmetric and asymmetrical vertical loads in car, longitudinal loads and different loading situations.

Vehicle Layout Design:

preliminary design, Load distribution on vehicle structure, stress analysis of bus body structure under bending and torsion, stress analysis in integral bus body, Design of chassis frame, Rules and regulations for body, Recent safety measures, Testing of body. L1,L2,L3,L4

Module-5

Vehicle Safety:

Active and passive safety, Restraint systems used in automobiles: safety belts, Head restraints, Air bags, Knee bolsters, Importance of Bumpers and their design, Types of safety glass and their requirements, Importance of Ergonomics in Automotive safety- Locations of controls.

Vehicle Structures for Crash Worthiness:

Types of crash / roll over Tests, Regulatory requirements for crash testing, Instrumentation, high speed photography, Image Analysis. L1,L2, L3,L4

After completion of above course, student will be able to:

1. Chassis layouts of passenger and commercial vehicles.
2. Select the appropriate dimensions for drivers seat, passenger seat, drivers and passengers cabin as per ergonomic requirements.
3. Select appropriate body material
4. To calculate aerodynamic forces and moments acting on vehicle body, can be able to select suitable flow visualization technique.
5. Select suitable method for reduction in aerodynamic forces and moments in heavy vehicles.
6. Calculate load distribution leading to ergonomics, stability and safety of the vehicle.
7. Identify the various safety aspects in a given vehicle.

Text Books:

1. Pawloski J., Vehicle Body Engineering- Business Books Ltd.
2. Reimpell J, The automotive chassis: Engineering principle - 2nd Edition, 1983.

Reference Books:

1. Watts, A. J., et al, Low speed Automobile Accidents, Lawyers and Judges 1996.
2. JullianHappian, Smith ,An Introduction to Modern Vehicle Design, SAE, 2002

VEHICLE DYNAMICS
[As per Choice Based Credit System (CBCS) scheme]
II SEMESTER

Course Code	**18MAU241**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**04 (50 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

Course Objectives: This course will enable students to

- Understand basics of vibrations
- Analyze forces acting and the performance characteristics of tyres and brakes
- Analyze vehicle dynamics and its influence on the vehicle handling characteristics
- Explain principles of Steady State Handling Characteristics of Road Vehicles

Module-1

Basics of Vibration:

Definitions, Modeling and Simulation, Global and Vehicle Coordinate System, Free, Forced, Un-damped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Multi DOF, Magnification factor, Transmissibility, Vibration absorber, Vibration measuring instruments, Torsional vibration, Critical speed. Modal analysis. L1,L2,L3

Module-2

Tyres:

Tyre forces and moments, Tyre structure, Longitudinal and Lateral force at various slip angles, rolling resistance, tractive and cornering property of tyre. Performance of tyre on wet surface. Ride property of tyres. Magic formulae tyre model, Estimation of tyre road friction. Test on Various road surfaces. Tyre vibration.

Braking Performance:

Basic equations, Braking forces, Brakes, Brake Proportioning, Antilock Brake system, Braking efficiency, Rear wheel lockup, Standards and Legislations, Numerical Examples.L1,L2,L3

Module-3

Vertical Dynamics:

Human response to vibration, Sources of Vibration. Design, analysis and computer simulation ofPassive, Semi-active and Active suspension using Quarter car, half car and full car model. Influence of suspension stiffness, suspension damping, and tyre stiffness. Control law for LQR, H-Infinite, Skyhook damping. Air suspension system and their properties.

Vehicle Aerodynamics:

Aerodynamic, Aerodynamic forces lift and drag components, Pitching, yawing,

rolling moments, and Total road loads, Numerical Examples.L1, L2, L3, L4

Module-4

Steady State Handling Characteristics of Road Vehicles;

Steering Geometry, Derivation of fundamental equation governing the steady-state handling behavior of a road vehicle, Neutral Steer, Understeer and Oversteer characteristics, characteristic and critical speeds, Neutral Steer Point, Static margin, Steady-State Response to Steering Input-Yaw Velocity Response, Lateral Acceleration Response, Sideslip Response and Curvature Response; Numerical Problems.

Performance Characteristics of Off-Road Vehicles:

Drawbar Performance - Drawbar Pull and Drawbar Power, Tractive Efficiency, Coefficient of Traction, Weight-to-Power Ratio for Off-Road Vehicles; Fuel Economy of Cross-country Operations Transport Productivity and Transport Efficiency, Mobility Map and Mobility Profile, Selection of Vehicle Configurations for Off-Road, Numerical Problems.L1, L2, L3, L4.

Module-5

Suspension Mechanisms:

Solid Axle Suspension, Independent Suspension, Roll Center and Roll Axis, Car Tire Relative Angles, Toe, Caster Angle, Camber, Trust Angle, Suspension Requirements and Coordinate Frames, Kinematics Requirements, Dynamic Requirements, Wheel, wheel body, and tyre Coordinate Frames, Caster Theory, Numerical examples.L1, L2, L3

Course outcomes:: After completion of above course, student will be able to:

1. Explain basics of vibrations.
2. Analyze forces acting and the performance characteristics of tyres and brakes.
3. Analyze vehicle dynamics and its influence on the vehicle handling characteristics.
4. Explain principles of Steady State Handling Characteristics of Road Vehicles.

Text Books:

1. Reza N. Jazar, Vehicle Dynamics, Theory and Applications, Springer Verlag.
2. J. Y. Wong, Theory of Ground Vehicles, John Willey & Sons, NY.
3. T D Gillespie, Fundamentals of Vehicle Dynamics, SAE.

Reference Books:

1. Hans B. Pacejka, Tyre and Vehicle Dynamics, SAE
2. Giancarlo Genta, Motor Vehicle Dynamics: Modeling and Simulation, World Scientific Publishing Co.; Singapore.
3. Hucho W. H., Aerodynamics of Road Vehicles, SAE.
4. Thomas D. Gillespie, Fundamentals of Vehicle Dynamics, Society of Automotive Engineers Inc., 1992
5. Rajesh Rajamani, Vehicle Dynamics and Control,1st edition, Springer, 2005.

VEHICLE PERFORMANCE [As per Choice Based Credit System (CBCS) scheme] II SEMESTER			
Course Code	**18MAU242**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**04 (50 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

Course Objectives: This course will enable students to

- Understand various factors effecting vehicle performance
- Understand basics of tyre design.
- Calculate vehicle power plant and transmission requirements.
- Select drivelines for vehicle.

Module-1

Introduction to Vehicle System:
Morphology of vehicles, General layout of passenger cars and commercial vehicle, Type of power units, arrangement of power train, Vehicle controls.
L1,L2,L3

Module-2

Friction and Rolling Resistance of Pneumatic Tyres:
Aerodynamics forces and moments, Relationship between tractive effort and longitudinal slip of tyres, cornering properties of tyres, Equation of motion and maximum tractive effort.L1,L2,L3

Module-3

Vehicle Performance Estimation and Prediction:
Power plant characteristic and transmission related requirements, Vehicle acceleration, and max. Speed, Gradability Drive systems comparison.
L1, L2, L3

Module-4

Vehicle Transmissions:
Characteristics and features friction clutches, mechanical geared transmission lay shaft and epicyclic gearbox, Synchronizers, Fluid coupling and torque converters. Drive lines, two wheel drive, four wheel drive, braking arrangement, safety in braking, weight transfer steering, and cornering power of tyres.L1, L2, L3

Module 5

Handling Characteristics of Vehicles:
Steering geometry, steady state handling characteristics, steady state response to steering input. Directional stability of vehicle. Effect of shock and vibration on human being, comfort criteria.L1, L2, L3, L4

Course outcomes:: After completion of above course, student will be able to:

1. Explain various parameters affecting the performance of a vehicle.
2. Explain significance of Friction and rolling resistance of pneumatic tyres.
3. To study the performance of different Vehicle transmissions.
4. Analyze Handling characteristics and stability of vehicles.

Text Books:

1. Rao J.S. and Gupta. K., Theory and Practice of Mechanical Vibrations-, Wiley Eastern Ltd., 2ndEdition,2002.
2. J. Y. Wong, Theory of ground vehicle, John Wiley and Sons Inc., New York,1stEdition, 1978.
3. Dr. N. K. Giri,Automobile Mechanics, Seventh reprint, Khanna Publishers, Delhi, 3rdEdition,2005

Reference Books:

1. W. Steeds, Mechanics of road vehicle- Illiffe Books Ltd, London3rdEdition, 1992.
2. - J. G. Giles, Steering, Suspension tyres, Illife Books Lid London1st Edition, 1975.
3. P. M.Heldt, Automotive chassis Chilton Co,New York, 1st Edition,1982.
4. J. R. Ellis, Vehicle DynamicsBusiness Books, London, 2ndEd.,1969.

AUTOMOTIVE CONTROL SYSTEMS
[As per Choice Based Credit System (CBCS) scheme]
II SEMESTER

Course Code	**18MAU243**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

Course Objectives: This course will enable students to

- Understand requirement of controls systems for automotive sytems.
- Gain sufficient knowledge about controlling various automotive systems
- Understand working principle and applications of various sensors for different applications.
- Use control systems for controlling various automotive systems like fuel control, ignition control, speed control, etc.
- Select vehicle control systems for preserving stability and comfort.

Module-1

Chassis and Drive Line Control:

Components of chassis management system – role of various sensors and actuators pertaining to chassis system – construction – working principle of wheel speed sensor, steering position, tyre pressure, brake pressure, steering torque, fuel level, Engine and vehicle design data

Drive Line Control:

Speed control - cylinder cut - off technology, Gear shifting control – Traction / braking control, brake by wire -Adaptive cruise control, throttle by wire. Steering - power steering, collapsible and tiltable steering column,steer by wire. L1, L2, L3

Module-2

Engine Management System:

Basic Engine Operations – Fuel Control, Ignition control, Lambda Control, Idle Speed Control, Knock Control , Open Loop and Closed Loop Control

Sensors:

Basic sensor arrangement; Types of sensors such as oxygen sensors, Crank angle position sensors, fuel metering/vehicle speed sensors and detonation sensors, altitude sensors, flow sensors, throttle position sensors, solenoids. L1,L2,L3

Module-3

Safety and Security Systems: Airbags, seat belt tightening system, collision warning systems, child Lock, anti-lock braking systems, Vision enhancement - Static and dynamic bending of Head light, road recognition system, Anti-theft technologies, smart card system, number plate coding, central locking system. L1, L2, L3.

Module-4
Comfort and Vehicle Control System: Active suspension systems, requirement and characteristics, different types, Vehicle Handling and Ride characteristics of road vehicle, pitch, yaw, bounce control, power windows, adaptive noise control. ABS Control System – Torque Balance at Wheels road contact – Control cycle of ABS System – Advantages – Traction control system- Combination of ABS with Traction control system. L1,L2,L3
Module-5
Intelligent Transportation System: Traffic routing system - Automated highway systems - Lane warning system - Driver Information System, driver assistance systems - Data communication within the car, Driver conditioning warning - Route Guidance and Navigation Systems-vision enhancement system, In-Vehicle Computing-Vehicle Diagnostics system. VANET usage in Automobiles. L1,L2,L3
Course outcomes:: After completion of above course, student will be able to: 1. Explain basics and different types of control system required for the Automotive vehicle for improvement of performance of vehicle. 2. To gain knowledge of safety and security systems 3. Use control system for improvement of Comfort and Vehicle Control System. 4. Use Intelligent Transportation System effective utilization of fleet.
Text Books: 1. U. Kiencke, and L. Nielsen, Automotive Control Systems,SAE and Springer-Verlag, 2000. 2. LjuboVlacic, Intelligent Vehicle Technologies- Michel Parent, Fumio Harashima, Butterworth- Heinemann publications,Oxford, 2001.
Reference Books: 1. Crouse, W.H. &Anglin, D.L., Automotive Mechanics, Intl. Student edition, 9th edition, TMH, New Delhi, 2002. 2. William B.Ribbens, Understanding Automotive Electronics,5th edition, Butter worth Heinemann Woburn,1998. 1. Automotive HandBook- Bosch, 8th edition, SAE, 2007.

ADVANCED MACHINE DESIGN
[As per Choice Based Credit System (CBCS) scheme]
II SEMESTER

Course Code	**18MAU251**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

Course Objectives: This course will enable students to

- Understand basics of mechanical failures in various types of materials.
- Understand failure of materials due to fatigue and analyze it.
- Apply knowledge for failure analysis at notches, failure due to corrosion, wear and contacts etc. and take necessary action to reduce it.

Module-1

Introduction:
Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr's theory and modified Mohr's theory, Numerical examples.

Fatigue of Materials: Introductory concepts, High cycle and low cycle fatigue, Fatigue design models, Fatigue design methods, Fatigue design criteria, Fatigue testing, Test methods and standard test specimens, Fatigue fracture surfaces and macroscopic features, Fatigue mechanisms and microscopic features. L1, L2, L3

Module-2

Stress-Life (S-N) Approach:
S-N curves, Statistical nature of fatigue test data, General S-N behavior, Mean stress effects, Different factors influencing S-N behaviour, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using SN approach.

Strain-Life (ε-N) approach:
Monotonic stress-strain behavior ,Strain controlled test methods ,Cyclic stress strain behavior ,Strain based approach to life estimation, Determination of strain life fatigue properties, Mean stress effects, Effect of surface finish, Life estimation by ε-N approach. L1, L2, L3, L4

Module-3

LEFM Approach:
LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation. Notches and their effects: Concentrations and gradients in stress and strain, S-N approach for notched membranes, mean stress effects and Haigh diagrams, Notch strain analysis and the strain – life approach, Neuber's rule, Glinka's rule,

applications of fracture mechanics to crack growth at notches. L1, L2, L3

Module-4

Fatigue from Variable Amplitude Loading:

Spectrum loads and cumulative damage, Damage quantification and the concepts of damage fraction and accumulation, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods, Life estimation using stress life approach. L1, L2, L3, L4

Module-5

Surface Failure:

Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue spherical contact, Cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength. L1, L2, L3

Course outcomes: After completion of above course, student will be able to:

1. Design machine components which are subjected to fluctuating loads.
2. Use LEFM approach for crack growth determination.
3. Design machine components/parts based on creep criterions. They are able to implement the concept of reliability for designing a machine parts or machine.
4. Explain the contact stresses and implementation of Hertz contact phenomenon to the real field problem. Identify failure modes and evolve design by analysis methodology.
5. Design against fatigue failure is given explicit attention.

Text Books:

1. Stephens, Ali Fatemi, Robert, Henry o. Fuchs, Metal Fatigue in engineering, Ralph I. Johnwiley NewYork, Second edition. 2001.
2. Jack. A. Collins, Failure of Materials in Mechanical Design, John Wiley, Newyork 1992.
1. Robert L. Norton, Machine Design, Pearson Education India, 2000.

Reference Books:

2. S .Suresh, Fatigue of Materials, Cambridge University Press,-1998.
3. Julie .A. Benantine, Fundamentals of Metal Fatigue Analysis, Prentice Hall,1990.
4. Fatigue and Fracture, ASM Hand Book, Vol. 19, 2002.

SIMULATION OF I. C. ENGINE PROCESSES
[As per Choice Based Credit System (CBCS) scheme]
II SEMESTER

Course Code	**18MAU252**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**04 (50 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

Course Objectives: This course will enable students to

- Understand various numeric techniques used in the automotive system and sub system simulations.
- Design and Evaluation of Simulation Experiments.
- Simulate of SI and CI engines combustion process.

Module-1

Principle Of Computer Modeling and Simulation:
Monte Carlo simulation, Nature of computer modeling and simulation, advantages of simulation, limitations of simulation, and areas of application.

System and Environment:
Components of system-discrete and continuous systems. Models of a system-a variety of modeling approaches. L1, L2, L3

Module-2

Design and Evaluation of Simulation Experiments:
Variance reduction techniques-antithetic variables- variables verification and validation of simulation models. L1,L2,L3

Module-3

S.I. Engine Simulation and Two Stroke Engine:
Simulation of Otto cycle at full throttle, part throttle and supercharged conditions. Progressive combustion, Exhaust and intake process analysis. Two Stroke Engine Simulation-Engine and Porting Geometry, Gas Flow, Scavenging. L1, L2, L3

Module-4

C.I. Engine Simulation:
Simulation of ideal Diesel cycle and Diesel cycle at full throttle, part throttle and supercharged conditions. Zero dimensional combustion model, Progressive combustion, Exhaust and intake process analysis. L1, L2, L3

Module 5

Simulation Exercises:
Case studies of Simulation for 2 stoke and 4 stroke engine. Simulation exercises using computers – MATLAB/SimuLink, Pro-E / ICEM, CFD Analysis, FE Analysis procedures, Advantages of FEA, Simple Exercise using MSC Nastran.

Multi-body Simulation Exercises:
Simple Multi-body Suspension, Four Bar mechanisms, Handling Analysis of

simple Bogie using MSC Adams. L1, L2, L3, L4

Course outcomes:: After completion of above course, student will be able to:

1. Device various numeric techniques being used in the automotive system and sub system simulations.
2. Design and Evaluation of Simulation Experiments.
3. Simulate of SI and CI engines combustion process.

Text Books:

1. V. Ganesan, Simulation of Spark Ignition Engine Processes, Universities Press, 1995.
2. V. Ganesan, Computer Simulation of Compression Ignition Engine Processes , Universities Press, 1995.

Reference Books:

1. J. N. Mattavi and C. A. Amann, Combustion Modeling in Reciprocating Engines, Plenum Press, 1980.
2. Horlock and Winterbone, The Thermodynamics and Gas Dynamics of Internal Combustion Engines, Vol. I & II, Clarendon Press, 1986.
3. Gordon P. Blair, The Basic Design of two-stroke engines, SAE Publication, 1990.
4. J. I. Ramos, Internal Combustion Engine Modeling, Hemisphere Publishing Corporation, 1989
5. MSC Nastran / Adams User Manual
6. MATLAB User manual

OFF ROAD VEHICLES
[As per Choice Based Credit System (CBCS) scheme]
II SEMESTER

Course Code	**18MAU253**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**04 (50 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

Course Objectives: This course will enable students to

- Understand working and applications of earth moving equipment.
- Select suitable under carriage, hydraulics, steering systems for off road vehicles.
- Select suitable machine depending on type of land, haul distance, climate, etc.
- Formulate maintenance schedule for off road vehicles

Module-1

Equipment and Operation:

Different types, capacity, working principles and applications of bull Dozers, Loaders, Shovels, Excavators, Scrapers, Motor graders, Rollers, Compactors, Tractors and Attachments.

Module-2

Engine, under carriage and Suspension systems:

All systems of engine and special features like Automatic injection timer, turbochargers, after coolers etc., tyre and tracked vehicles, advantages and disadvantages under carriage components like, tracks, roller frames, drive sprockets, track rollers, track chains and track shoes. Rubber spring suspension and air spring suspension. L1, L2, L3

Module-3

Transmissions and Final drives:

Basic types of transmissions, auxiliary transmission, compound transmission, twin triple countershaft, transmissions and planetary, transmission, constructional and working principles, hydro shift automatic Transmission and retarders. FINAL DRIVES: types of reductions like, single reduction, double reduction final drives and planetary final drives PTO shaft. L1, L2, L3

Module-4

Hydraulics:

Basic components of hydraulic systems like pumps (types of pumps), control valves like flow control valves, directional control valves and pressure control valves, hydraulic motors and hydraulic cylinders, depth & draft control systems. L1, L2

Module 5

Criterions for selection of equipment:

Selection of machines based on type of soil, haul distance, weather condition, calculation of operating Capacity and calculation of productivity of a bull dozer.

Earth Moving Equipment Maintenance & Safety:

Types of maintenance schedules, purpose and advantages, organization set ups, documentation. Safety methods for earth moving equipment. L1, L2

Course outcomes:: After completion of above course, student will be able to:

1. Explain working and applications of earth moving equipment.
2. Select suitable under carriage, hydraulics, steering systems for off road vehicles.
3. Select suitable machine depending on type of land, haul distance, climate, etc.
4. Formulate maintenance schedule for off road vehicles.

Text Books:

2. Erich J.schulz., Diesel equipment- volume I andII
3. S. C. Sharma., Construction equipment and its management

Reference Books:

2. Donald R. hunt and L. W. Garner, Farm machinery and mechanism,
3. J. Y. Wong ,Theory of ground vehicles, john Wiley and sons.
4. Jagman Singh, On and with the earth, W. Newman and Co. Kalkata

AUTOMOTIVE ENGINEERING LAB –II [As per Choice Based Credit System (CBCS) scheme] II SEMESTER			
Subject Code	**18MAUL 26**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lab Hours	**50**	**Exam Hours**	**03**
Credits: 02			

Note:

- These are independent laboratory exercises
- A student may be given one or two problem
- Student must submit a comprehensive report on the problem solved and give a Presentation on the same.
- For Numerical Simulation, FEA software must be used such as MSC Patran/MSC Nastran and etc.
- For Multi body Dynamics simulation , MSC Adams or equivalent software can be used
- Electrical wiring diagram to be drawn with standard specifications colour codes.

List of Experiments	
1	Study of Suspension systems used in light, medium and Heavy vehicles.
2	Simulation of Suspension system using commercial software for LCV and HCV
3	Study of Driveline systems and Simulation using Commercial MBD software.
4	Stress Analysis of Chassis Components using FE Software.
5	Testing Two Wheeled Vehicles on Chassis Dynamometer.
6	Study and practice of wheel alignment (computerized) and wheel balancing.
7	Drawing electrical wiring layout for two, three and for wheeler vehicles
8	Study of Vehicle aerodynamic forces and moments in Wind tunnel.
9	Study of drivers visibility.
10	Impact Analysis of Automotive Vehicle System using FE Software.

TECHNICAL SEMINAR [As per Choice Based Credit System (CBCS) scheme] SEMESTER – II			
Subject Code	**18MAU27**	**CIE**	**100**
Number of Practical/ Field /assignments Hours/Week	**02**	**SEE**	**--**
Credits	**02**		
Technical Seminar: Technical Seminar should be delivered by students on recent trends in Automotive Technology. CIE marks shall be awarded by a committee comprising of HOD as Chairman, Guide/co-guide (if any) and a senior faculty of the department. Participation in seminar by all postgraduate students of the same and other semesters of the programme shall be mandatory.			

TWO AND THREE WHEELER TECHNOLOGY
[As per Choice Based Credit System (CBCS) scheme]
III SEMESTER

Course Code	**18MAU31**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**04 (50 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

Course Objectives: This course will enable students to

- Understand internal combustion engine requirements for two and three wheeled vehicle
- Lay down wiring diagram for two wheeler and three wheeled vehicles.
- Select frames, brakes and tyres, drive system for two and three wheeled vehicles.
- Laydown maintenance schedule for two and three wheeled vehicles.

Module-1

The Power Unit:

Types of engines for two wheelers, advantages and disadvantages of two stroke and four stroke engines, engine components, constructional details, materials, symmetrical and unsymmetrical port timing diagrams, valve actuating mechanisms, valve timing diagrams. Rotary valve engine, Advantages and disadvantages of diesel engines for two wheelers, power plant for electric bikes, exhaust systems. L1, L2

Module-2

Fuel, Lubrication and Cooling system:

Layout of fuel supply system, fuel tank construction, carburetor types, construction, working and adjustments. Types of cooling systems, advantages of air cooling system. Lubrication types, Lubrication of parts, grades of lubricating oils.

Electrical system:

Types of ignition system, their working principles, wiring diagram for Indian vehicles, spark plug construction, indicators and gauges used in two wheelers, lighting systems. L1,L2,L3

Module-3

Transmission system:

Primary drive and Clutch:

Motor cycle power train, Primary drives, Types of primary drives, Chain drive, Gear drive, Construction and operation of motorcycle clutches, Clutch release mechanism. Gear boxes.

Transmission:

Introduction to motorcycle transmission, Sprockets and chain, Gears and Dogs in motor cycle transmission, Gear and Gear ratios, Sliding gear transmissions, Shifting fork mechanisms, Constant mesh transmissions and lubrication.

Final drive:
Introduction to motorcycle final drives, Fundamentals of chain drive, Chain lubrication and lubricators, Shaft drives, Drive shaft couplings, Final drive gear case. L1, L2, L3

Module-4

Frames and suspension:
Types and constructional details of frames, advantages and limitations, frame materials, frame stresses, frame building problems, frame components, Front and Rear suspension systems, shock absorber construction and working, Panel meters and controls on handle bar, body manufacture and painting.

Brakes and Wheels:
Front and rear braking systems, disc and drum brakes, merits and demerits, Types of wheels, loads on wheels, construction and materials for wheels, wheels designation, tyre designation, inflation, types of tyres, construction details. L1, L2, L3

Module 5

Two wheelers and Three wheelers:
Case study of major Indian models of major motor cycles, scooters, scooteretts and mopeds. Case study of Indian models of three wheelers, Front mounted engine and rear mounted engine types, Auto rickshaws, pick up van, delivery van and trailer.

Maintenance:
Importance of maintenance, Decarburizing procedure for engine and silencer, periodic inspection, maintenance schedules, trouble diagnosis charts, safety precautions, Lubrication charts. L1, L2

Course outcomes:: After completion of above course, student will be able to:

1. Describe construction and working of different type of internal combustion engines for two and three wheeled vehicles.
2. Laydown wiring diagram for two wheeler and three wheeled vehicles.
3. Select clutches transmission and final drives for two and three wheeled vehicles.
4. Describe types of frames, brakes and tyres used for two and three wheeled vehicles.
5. Laydown maintenance schedule for two and three wheeled vehicles.

Text Books:

1. Motor cycle engines - P. E. Irving, Temple Press Book, London, 1992
2. Motor cycles -Michel M. Griffin
4. Motor cycle Mechanics - William H. Crouse and Donald L. Anglin, TMH

Reference Books:

1. The cycle Motor manual - Temple Press Ltd, 1990
2. Vespa maintenance and repair series - Bryaut R. V.

2. Encyclopedia of Motor Cycling 20 volumes - Marshall Cavendish, NY, 1989.

HYBRID VEHICLE TECHNOLOGY
[As per Choice Based Credit System (CBCS) scheme]
III SEMESTER

Course Code	**18MA321**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**04 (50 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

Course Objectives: This course will enable students to

- Understand need for Hybrid vehicle
- Select the hybrid configuration for vehicle
- Decide selection of suitable size and type of prime mover
- Select type of storage battery and fuel cell.

Module-1

Hybrid Vehicles:
Introduction to HVs, Performance characteristics of road vehicles; calculation of road load, predicting fuel economy, grid -connected hybrids.

Hybrid architecture:
Series configuration- locomotive drives, series parallel switching, load tracking architecture. Pre transmission parallel and combined configurations-Mild hybrid, power assist, dual mode, power split, power split with shift, Continuously Variable transmission (CVT), wheel motors L1, L2, L3

Module-2

Propulsion methods:
DC motors-series wound, shunt wound, compound wound and separately excited motors AC motors-Induction, synchronous, brushless DC motor, switched reluctance motors. L1, L2, L3

Module-3

Hybrid power plant specifications:
Grade and cruise targets, launching and boosting, braking and energy recuperation, drive cycle implications, engine fraction-engine downsizing and range and performance, usage requirements.

Sizing the drive system:
Matching electric drive and ICE, sizing the propulsion motor; sizing power electronics. L1, L2, L3

Module-4

Energy storage technology:
Battery basics; lead-acid battery; different types of batteries; battery parameters, Battery Recycling.

Fuel cells:
Fuel cell characteristics, fuel cell types – alkaline fuel cell, proton exchange Membrane; direct methanol fuel cell, phosphoric acid fuel cell, molten

carbonate fuel cell, solid oxide fuel cell, hydrogen storage systems, reformers, fuel cell EV, super and ultra capacitors. L1, L2, L3

Module 5

Non-electric Hybrid Propulsion Systems:

Short-Term Storage Systems- Flywheel Accumulators. Continuously Variable Transmissions Hydraulic Accumulators Hydraulic Pumps/Motors, Pneumatic Hybrid Engine Systems- Operation Modes. L1, L2, L3

Course outcomes: After completion of above course, student will be able to:

1. Explain need for hybrid vehicle, their layouts.
2. Differentiate types of DC motors, different types of AC motors, advantages & disadvantages of DC&AC motors used for propulsion.
3. Select drive system, storage battery and capacitors and flywheel.

Text Books:

1. The Electric Car: Development & Future of Battery, Hybrid & Fuel-Cell Cars - Mike Westbrook, M H Westbrook, British library Cataloguing in Publication Data.
2. Electric and Hybrid Vehicles- Robin Hardy, Iqbal Husain, CRC Press.
3. Propulsion Systems for Hybrid Vehicles- John M. Miller, Institute of Electrical Engineers, London.

Reference Books:

1. Energy Technology Analysis Prospects for Hydrogen and Fuel Cells, International Energy Agency, France.
2. Handbook of Electric Motors- Hamid A Toliyat, Gerald B Kliman, Marcel Decker Inc.

AUTOMOTIVE EMBEDDED SYSTEMS
[As per Choice Based Credit System (CBCS) scheme]
III SEMESTER

Course Code	**18MAU322**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

Course Objectives: This course will enable students to

- Understand basics of use of electronic in automobiles
- Understand various design requirements of drive by wire system
- Understand Hardware modules and softwares used in automotive embedded systems
- Decide integration of hardware and software

Module-1

Electronics in Automotive:
Introduction Body and convenience electronics: vehicle power supply controllers and lighting modules, door control modules, Safety electronics: active safety systems: ABS, ASR, ESP passive safety systems: Restraint systems and their associated sensors in an automobile.

Powertrain Electronics: Gasoline engine management, Infotainment electronics: Dashboard/instrument cluster, car audio, telematic systems, navigation systems, multimedia systems, cross application technologies. 42V vehicle power supply system. L1,L2,L3

Module-2

Drive by Wire:
Challenges and opportunities of X-by-wire: system & design requirements steer-by-wire, brake-by-wire, suspension-by-wire, gas-by-wire, power-by-wire, shift by-wire. Future of Automotive Electronics. L1,L2,L3

Module-3

Hardware Modules:
MC9S12XD family features-Modes of operation-functional block diagram overview-programming model. Memory Map Overview Pulse Width Modulator (PWM)-On-chip ADC Serial Communication Protocol: SCI, SPI,IIC, CAN. L1, L2, L3

Module-4

Software Development Tools:
Introduction to HCS12XDT512 Student Learning Kit & PBMCU (Project Board) –Introduction to Code Warrior IDE-Editing-Debugging-Simulating simple programs. Flashing code into HCS12XDT512 SLK board and testing. L1,L2,L3

Module-5

Integration of Software and Hardware:

Downloading the Software from Host Machine to Target Machine. Implementing application prototype: Power Window and Automotive Lighting System L1, L2
Course outcomes:: After completion of above course, student will be able to: 1. Explain basics of Automotive Embedded system concepts, 2. Select embedded system in automobiles. 3. Use hardware and usage software in Automotive Embedded System 4. Use different software development tools. 5. Integrate Software and Hardware.
Text Books: 5. Semiconductors-Technical Information, Technologies and characteristic data, Publicis Corporate Publishing 2nd revised edition, 2004, 6. Freescale MC9S12XDP512 data sheet. 7. Ronald K Jurgen, Automotive Electronics Handbook,McGraw Hill, 2000.
Reference Books: 1 Werner Klingenstein & Team, Semiconductors, Technical Information, Technologies and Characteristic Data- Publicis Corporate Publishing, 2nd edition, 2004. 2 Ljubo Vlacic, Michel Parent &FurnioHarshima, Intelligent Vehicle Technologies: Theory and Applications, Butterworth-Heinemann publications, 2001.

MANUFACTURING TECHNIQUES IN AUTOMOTIVE ENGINEERING
[As per Choice Based Credit System (CBCS) scheme]
III SEMESTER

Course Code	**18MAU323**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

Course Objectives: This course will enable students to

- Understand sheet metal forming processes
- Understand Forging process
- Select suitable Powder Metallurgy Process
- Select suitable metal joining methods used in automobiles.
- Use plastic joining methods

Module-1

Sheet Metal Forming:
Introduction, Forming methods, shearing and Blanking, Bending, stretch forming, Deep drawing, redrawing operations, Defects in formed products.

High Energy Rate Forming:
Explosive forming, Electro-hydraulic forming, Electro-magnetic forming, Super Plastic Forming - Process principles, Equipment, Process variables, Merits and Limitations. L1, L2, L3

Module-2

Forging:
Classification, various stages during forging, Forging equipment, brief description, deformation in compression, forging defects. Residual stresses in forging.

Special Casting processes:
Gravity die-casting, Pressure die casting, Centrifugal casting, Squeeze Casting, Slush casting, Thixo-casting and Continuous Casting Processes. Different casting techniques for manufacturing of automotive components like cylinder block, piston, flywheel, bearing liners, etc. L1, L2, L3

Module-3

Powder Metallurgy Processing:
Process details and special characteristics of Powder Metallurgy process, Powder making methods, Characteristics of Powders, Process flow chart, Process steps and Process variables.
Compaction techniques like CIP & HIP (Cold Iso-static and Hot Iso-static pressing), Product design considerations, Applications of Powder metallurgy.
L1, L2, L3

Module-4

Joining methods- Fusion:
MIG-CO_2 welding, Flux Cored Arc Welding, Resistance Seam, Spot and

Projection Welding-Process principles, Equipment, Process variables, Merits and Limitations.

Solid State Welding:

Friction Welding, Friction Stir Welding - Process principles, Equipment, Process variables, Merits and Limitations. L1, L2, L3

Module-5

Joining of Plastics:

Heated tool welding or hot bar welding, Hot gas welding or pendulum welding, High frequency welding, Ultrasonic welding, Friction welding, Induction welding. L1, L2

Course outcomes: After completion of above course, student will be able to:

- Use sheet metal forming processes for sheet formin
- Select suitable Forging process production of automotive components.
- Select suitable Powder Metallurgy Process
- Select suitable metal joining methods used in automobiles.
- Use plastic joining methods

Text Books:

1. Sach G., Fundamentals of Working of Metals, Pergamon Press.
2. R. A. Flinn & P. K. Trojan, Engineering Materials & their applications, 4th edition, Jaico Publishing House.

Reference Books:

1. ASM Handbook on Powder Metallurgy, Volume 17, ASM publications
2. High speed combustion engines- P.M. Heldt, Oxford and IBH Publishing Co, New York, 1990.
3. AWS Hand Book on welding.

VEHICLE AERODYNAMICS
[As per Choice Based Credit System (CBCS) scheme]
III SEMESTER

Course Code	**18MAU331**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**04 (50 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

Course Objectives: This course will enable students to

- Understand basics of vehicle aerodynamics
- Analyze the stability of vehicle and comfort to occupants
- Conduct wind tunnel testing for flow visualization and to calculate different aerodynamic forces
- Create aerodynamic Design vehicle body using CFD.

Module-1

Fundamentals of Aerodynamics:
Scope- concept of bluff body, Generic Shapes, relevance of these shapes to ground vehicles. Pressure drag and viscous drag, flow phenomenon related to vehicles- External and Internal flows, Resistance to vehicle motion, flow field around car, aerodynamic development of cars, Optimization of car bodies for lower drag. L1, L2

Module-2

Stability, Safety and Comfort:
The origin of forces and moments- effects- vehicle dynamics, under side wind forces and moment coefficients- safety limits, design stage measures, important factors affecting aerodynamics like rear slant, cross winds, engine cooling air flow, underbody flow, wheel rotation, air flow around individual components, high performance vehicles, very long vehicles, design alternatives L1,L2,L3

Module-3

Wind Tunnels and Test Techniques:
Principles of wind technology- limitations of simulation- simulation based optimization of geometrics, drag reduction technologies- surface shaping, scaled models. Wind tunnel experiments- measurement of pressure coefficients, drag force, wind tunnel limitations and corrections- boundary layer control, wind tunnel blockage, climatic tunnels, measuring equipment and transducers-pressure measurement, velocity measurement, flow visualization techniques, Wind noise measurement. L1, L2, L3

Module-4

Application of CFD:
Methods to solve Navier – stoke equations, forces acting on fluid element, compressibility effect in a flow field, inviscid flow, governing equations, irritation flow field and consequences, potential flow, boundary layer methods.

Important requirements of CFD solvers, Geometric/ Dynamic similarity, robust flow solver. Turbulence models, Numerical modelling of fluid flow around vehicle body. L1, L2, L3.

Module-5

Aerodynamic Design:

Development and simulation of cars, buses, trucks, surface motion, surface permeability, mass addition, energizing flow around the vehicle. L1, L2, L3, L4

Course outcomes:: After completion of above course, student will be able to:

- Explain and apply basics of vehicle aerodynamics
- Analyze the stability of vehicle and comfort to occupants
- Conduct wind tunnel testing for flow visualization and to calculate different aerodynamic forces

1. Create aerodynamic Design vehicle body using CFD.

Text Books:

1. W. H. Hucho, Aerodynamics of Road vehicles, Butterworth and Co, 2004.
2. Schlichting H., Boundary Layer Theroy , Mc. Graw Hill, New York, 1999
3. Pope A., Low speed Wind tunnel Testing, John Wiley and Sons, New York, 1999.

Reference Books:

1. Milliken and Milliken, Race car Vehicle Dynamics, Theory and application.
2. Vehicle Aerodynamics, SAE 1996

AUTOMOTIVE MATERIALS
[As per Choice Based Credit System (CBCS) scheme]
III SEMESTER

Course Code	**18MAU332**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

- **Course Objectives:** This course will enable students to
- Understand properties of various materials used for automobile body construction.
- Select various constituents and manufacturing techniques for manufacturing of composite materials.
- Necessary techniques to analyze the composites.

Module-1

Aluminium Alloys & Lightweight Magnesium for Automotive Applications: Introduction; Wrought aluminium alloys; Cast aluminum processes Technologies; Cast aluminium metallurgy and properties; New Lightweight alloys; Process technologies; mechanical and physical properties; Case studies of applications.

Testing Automotive Materials:

Evaluation of materials under realistic loading and environmental conditions; different test methods for evaluation of properties for specific applications.

L1,L2,L3

Module-2

Composite Materials for Automotive Applications:

Definition, Classification, Types of matrices & reinforcements, characteristics & selection, Fiber composites, laminated composites, particulate composites, prepegs, sandwich construction.

Manufacturing Composite Materials:

Lay up and curing – open and closed mould processing – Hand lay –up techniques – Bag moulding and filament winding. Pultrusion, pulforming, Thermoforming, Injection moulding, Cutting, Machining and joining, tooling, Quality assurance – Introduction, material qualification, types of defects, NDT methods. L1, L2, L3

Module-3

Metal Matrix Composites:

Reinforcement materials, types, Characteristics & selection, base metals, selection, applications in automotive engineering. L1,L2,L3

Module-4

Micro Mechanical analysis of a Lamina:

Introduction, Evaluation of the four elastic modules – Rule of mixture, ultimate strengths of unidirectional lamina.

Macro mechanics of a Lamina:

Hooke's law for different types of materials, number of elastic constants; Two – dimensional relationship of compliance & stiffness matrix. Hooke's law for two dimensional angle lamina, engineering constants – angle lamina, Invariants, Theories of failure. L1, L2, L3, L4

Module-5

Macro Mechanics of Laminates:

Laminates Coding, ABD Matrices, Classical Laminates Theory, Special cases of Laminates, Strength Theories of Laminates. L1, L2, L3

Course outcomes: After completion of above course, student will be able to:

- Explain properties of various light metals used for vehicle body construction.
- Select suitable materials for making composite materials.
- Apply basics of strength of materials and theories of failure for analysis of laminates.
- Analyse failure of materials by using NDT techniques.

Text Books:

2. James M Boileau, Developments in Lightweight Alloys for Automotive Applications-, 2001-2005, SAE (Product Code PT-130).
3. ThomesRuden, Lightweight Magnesium Technology, 2001 through 2005, SAE (Product code PT-131)

Reference Books:

1. Donald H Wright, Testing Automotive Materials & Components SAE (Product Code R – 124)
2. Krishan K. Chawla, Composite material science and Engineering-, Springer.
3. P. C. Mallik , Marcel Decker, Fibre reinforced composites.

FINITE ELEMEMNT METHOD
[As per Choice Based Credit System (CBCS) scheme]
III SEMESTER

Course Code	**18MAU333**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50 (10 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

Course Objectives: This course will enable students to

- Understand basics of finite element analysis
- Calculate the stiffness matrix and stress- strain distribution for one dimension, two dimensional, three dimensional conditions.
- Simulate dynamic conditions for given model.

Module-1

Introduction to Finite Element Methods:
Engineering analysis, History, advantages and disadvantages, classification, basic concepts, convergence criteria. Role of finite element analysis in computer aided design, mathematical preliminaries, and differential equation formulation. Variational formulations, weighted residual methods. L1, L2, L3

Module-2

One Dimensional Elements:
Analysis of bars and trusses, basic equations and Potential Energy functional. 1D Bar Element, Admissible displacement function, strain matrix, stress recovery, Element equation, stiffness matrix. Consistent nodal force vectors: Body force, initial strain, assembly procedure, Boundary and constraint conditions, single point constraint, multi point constraint, truss element , shape functions for higher order elements, C^0, C^{-1} elements.
L1, L2, L3, L4

Module-3

Two Dimensional Elements:
Analysis of Plane Elasticity Problems: Triangular element, four noded quadrilateral Element(QUAD4), shape functions for higher order elements (LST and QUAD 8), Lagrange element, stain –displacement matrix, stiffness matrix and Jacobian of CST and QUAD4 elements.

Axi-symmetric Solid elements:
Analysis of Bodies of revolution under axi-symmetric loading, Axi-symmetric Triangular and Quadrilateral Ring Elements, Strain- Displacement matrix, stiffness matrix. L1, L2, L3

Module-4

Three dimensional elements:
Applications to Solid mechanics Problems: Basic Equations and Potential Energy Functional, Four Noded Tetrahdral Element, Eight - Noded Hexahedral Element, lagrange family, Shape Functions for Higher Order Elements.

Beam elements

Analysis of beam and frames: 1-D Beam element Problems. L1, L2, L3, L4

Module-5

Dynamic Considerations: Formulation of point mass and distributed mass, Consistent element mass matrix of one dimensional bar element, truss element, beam element , Lumped mass matrix, Evaluation of eigen values and eigen vectors. Applications to bars and beam elementL1

Heat Transfer:

Steady state heat transfer, 1D heat conduction governingequations. Functional approach for heat conduction. Galerkin's approach for heat conduction. 1D heat transfer in thin fins. L1, L2, L3, L4

Course outcomes:: After completion of above course, student will be able to:

1. Describe the fundamentals of structural mechanics and finite element method.
2. Develop element stiffness matrix for different elements using various methods.
3. Illustrate different methods of deriving shape functions for various elements.
4. Analyze structural and thermal problem.

Text Books:

1. T. R. Chandrupatla, A. D. Belegundu , Finite Elements in Engineering, 3rd Ed PHI.
2. S. S. Rao, Finite Element Method in Engineering, 4th Edition, Elsevier, 2006.

Reference Books:

1. U.S. Dixit, Finite Element Methods for Engineers, Cengage Learning, 2009
2. R. D. Cook, D. S Maltus, M. E. Plesha, R. J. Witt, Concepts and applications of Finite Element Analysis, Wiley 4th Ed, 2009
3. Daryl. L. Logon Finite Element Methods, Thomson Learning 3rdedition, 2001.
4. J. N. Reddy, Finite Element Method, McGraw -Hill International Edition.